**Report on experiment HE/2620 ID24 12-12-2007/17-12-2007**

An $YCo_5$ single crystal was prepared using the Czochralski technique. The furnace used for this experiment was recently built at Institut Néel (collaboration with Richard Haettel). The ingot extracted from the melt was not entirely single-crystalline, but large single crystalline pieces (of the order of 1 $cm^3$) were isolated from it. Following this successful test experiment, the preparation of an $(Y_{1-x}\text{-}Lu_x)Co_5$ single crystal was undertaken, as needed for the envisaged XMCD measurements at the Lu absorption edge on ID24. Two alloys were prepared with x = 0.5 and 0.25 respectively. None of them presented the expected $CaCu_5$-type structures. It might have been possible to stabilise the phase at lower Lu content, but the XMCD signal would have been too small then. We decided thus to shift system and selected $GdCo_5$. This compound crystallises in the same $CaCu_5$-type hexagonal structure as $YCo_5$ and other $RCo_5$ compounds. A large Co uniaxial magnetocrystalline anisotropy is present ($\mu_0 H_A \approx 40$ T at 4.2K and 300K), the origin of which is expected to be the same as in other $RCo_5$ compounds (including $YCo_5$). Several single crystalline samples were prepared, in the form of thin plates (actually wedges with an aperture angle of the order of 3°), with typical thickness around 20 μm, and with the easy c-axis either perpendicular to the plate or in the plane of the plate. The samples were characterised by X-ray diffraction and macroscopic magnetic measurements in a magnetic field up to 8T, using a VSM.

In all measurements on ID24, the pulsed magnetic field was parallel to the beam and the sample plate was inserted inside the pulsed magnetic field coil, with its plane surface perpendicular to the X-ray beam. The first measurements were realised at the Gd $L_{III}$ absorption edge (7243 eV), with a sample for which the easy c-axis was in-plane. The sample was attached to the sample holder through one side only and after a limited number of magnetic field shots, it got unstuck under the effect of the magnetic field torque. In all measurements realised later, the sample was more firmly attached to the sample holder and the above problem didn't occur again. We measured a clean XANES spectrum but were unsuccessful in measuring an XMCD signal in the whole temperature range. This was very puzzling. All technical causes for the absence of this signal, which we expected to be large and of amplitude substantially beyond our noise level, were checked by measuring a standard Gd $L_{III}$ XMCD signal on a metallic foil of Gd. The absence of this signal remains unclear and pushes us to consider further investigation in this direction.

Measurements at the $L_{II}$ wedges (7930 eV) were realised next. However, in this case, the XANES signal was extremely weak and difficult to analyse due to the fact that the energy of the absorption edge was above that of the Co K edge (7709 eV). In order to get better signal over background ratio, further thinning of the sample was realised. A cleaner signal was then obtained. However, due to the sample motion occurring during the magnetic field pulse (of the order of 50 μm), the sample absorption, in such ultra-thin samples, varied in some uncontrolled manner and it was impossible to extract reliable XCMD spectra from the data.

In view of pursuing the study of the anisotropy of the 5d hybridization in the $RCo_5$ compounds, we will propose to realise a new experiment on ID24, with $LaCo_5$ instead of $GdCo_5$. The energies of both the La $L_{II}$ (5891 eV) and La $L_{III}$ (5483 eV) absorption edges are both below that of the Co K absorption edge energy. The larger XMCD signals thus expected should permit an easier analysis of the results.